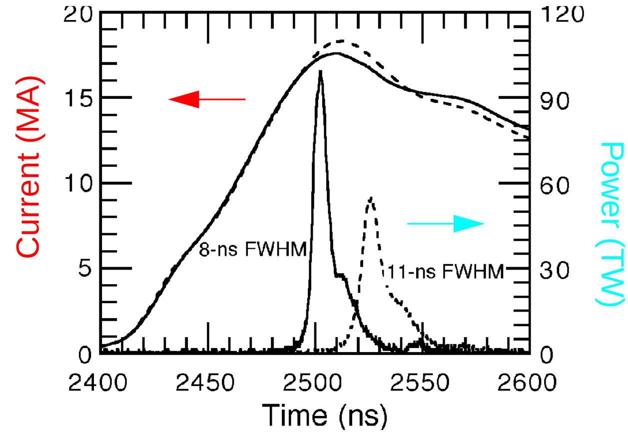
January 1997 Highlights of the Pulsed Power Inertial Confinement Fusion Program



Influence of radiation pulse width vs pinch collapse velocity for 17.5-mm-diameter radiation shots with 160 tungsten wires. Dashed lines are for shot 34; solid lines, for shot 39.

PBFA-Z experimental plans include: x-ray source development until mid March, then at one week per month through the end of FY97; vacuum hohlraum and imploding hohlraum experiments starting late March and early April. Experiments to optimize different z-pinch radiation source configurations will be interspersed with application experiments, such as shock physics, radiation flow, hole closure, and weapons physics.

We are continuing to study radiated energy and power scaling of small diameter (1.75-cm) wire array loads at full electrical charge (90 kV) on PBFA Z. Data have been obtained and analyzed for eight radiation shots at this array diameter, using 120 to 240 tungsten wires, each 18 to 12 µm in diameter. Analysis of the data suggests radiated power is a function of the individual *wire size* (i.e., diameter) as well as of the azimuthal symmetry and the collapse velocity of the pinch. Delivery of current and energy to the load is not as efficient with the 17.5-mm-diameter array as compared to the 40-mm-diameter array. We are reducing the current rise time to increase the implosion velocity and the x-ray powers (see figure).

The calibration techniques and data from the 11-channel x-ray diode array on the Saturn z-pinch experiments were reviewed. The uncertainties in the x-ray spectra are ~20%. In shots with a 12.5-mm-diameter array of 24 tungsten wires, the peak radiation observed from the walls of the 17.5-mm-diameter vacuum hohlraum is equivalent to a 77 $\pm$ 2 eV blackbody. With 40 wires, the peak temperature is 82 $\pm$ 2 eV. The x-ray spectrum from the walls is nearly Planckian. The temperature observed in off-axis secondary hohlraums is between 52 to 62 eV. Data from time-resolved x-ray pinhole cameras that view the secondary hohlraums show that a problem exists with diagnostic hole closure and that the peak temperature within the secondary hohlraums is actually higher than was observed with this diagnostic.

A nearly monochromatic x-ray backlighting system has been designed and tested at Cornell as an alternative to a costly short-wavelength laser to generate an x-ray backlighter to image radiating z-pinch plasmas. In this approach, an *X-pinch* plasma, initiated from two crossed wires, serves as the backlighter. A mica crystal bent to form a spherical reflecting surface images the object plasma in a single x-ray line from the X-pinch backlighter, using the Bragg reflection condition for the mica crystal. In an experimental study of the concept on the XP-pulser, 4-mm-long exploding wire plasmas of several materials (Al, W, and Mg) were imaged using radiation from crossed Al wires as the backlighter. The resulting backlighter source is intense compared to continuum radiation from the object plasma in the vicinity of the line, but the energy (1.87 keV for He-like Al) is too low and the size too large to image Saturn and PBFA-Z plasmas. The best backlighter candidate to image our z-pinch plasmas, among the X-pinch sources tested, is thought to be line radiation from He-like Ni at 7.8 keV. The X-pinch could be powered by a 300 kA, < 70 ns portion of the main accelerator pulse.

An FY97 milestone on SABRE is for the new high-magnetic-field capacitor banks to be operational in the ion mode. As part of this effort, we developed the capability to measure anode displacement with respect to the cathode during application of the field. The time-resolved radial displacement of the anode is 0.3 $\pm$ 0.1 mm during operation of the old magnetic-field banks, as measured with a He-Ne laser and a detector sensitive to the laser light position. This small displacement is not a problem at these field levels (3.3 tesla); in fact, initial misalignment of the cantilevered anode is of the same order. The ability to measure such displacements will be important for the larger (5 tesla) field that the new banks will supply, however, since the three times larger displacement force can affect the calculated magnetic insulation profile that is intended to produce a uniform current distribution in an extraction diode.

Contact: Jeff Quintenz, Inertial Confinement Fusion Program, Dept. 9502, 505-845-7245, fax: 505-845-7464, email: jpquint@sandia.gov

Highlights are prepared by Mary Ann Sweeney, Dept. 9502, 505-845-7307, fax: 505-845-7890, email: masween@sandia.gov.

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